Voyager Bulletin

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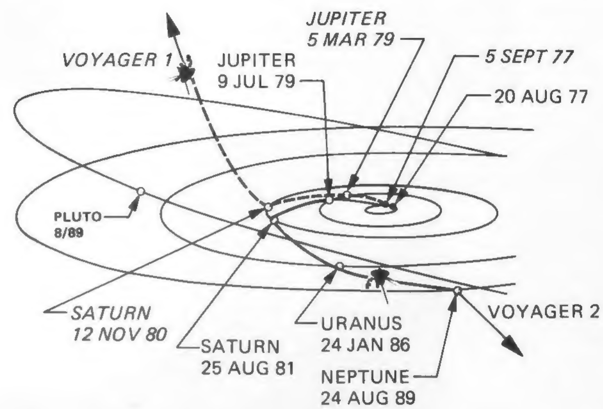
Two interplanetary explorers, Voyagers 1 and 2, continue to ply the solar system nearly eight and a half years after beginning their journeys to the outer planets.

Voyager 1, launched September 5, 1977, made its closest approach to Jupiter on March 5, 1979, and to Saturn on November 12, 1980. Voyager 1 is now escaping the solar system with a speed of about three and a quarter billion miles per year, 35 degrees above the ecliptic, the plane in which the planets orbit the Sun.

Voyager 2, launched on August 20, 1977, was placed on a slightly longer flight path that would allow it to become the first spacecraft from Earth to observe the planets Uranus and Neptune. It flew by the giant planet Jupiter on July 9, 1979 and then past the ringed planet Saturn on August 25, 1981. With the successful completion of the Jupiter and Saturn primary missions, the Voyager project received approval and funding to continue to track and operate both spacecraft. Voyager 2 will make its closest approach to Uranus on January 24, 1986, passing within 110,000 kilometers (68,000 miles) of the planet's center.

Although Voyager 1 will not encounter any more planets, it continues to measure fields and particles; to conduct astronomical observations in the ultraviolet; and, along with Pioneers 10 and 11, to search for the outer boundary of the solar wind. The Pioneer spacecraft are leaving the vicinity of the Sun in the plane of the ecliptic, but in opposite directions. How will we know when the spacecraft have entered interstellar space? First, the solar system has been defined in several ways. The simplest definition includes only the regions of the nine planets and their satellites. The most far-reaching includes everything that is gravitationally bound to the Sun, a region that extends out to the Oort cloud of comets at about 40,000 AU*. By the first definition, Pioneer 10 has exited the solar system, since it has passed beyond the orbit of Pluto. None of the spacecraft are anywhere near the Oort cloud. There is an intermediate definition of the solar system, called the heliosphere. This is the region populated by the solar wind, the charged particles flowing from the Sun. The heliosphere is thought to be shaped like a wind sock, with a bulbous leading edge in the direction the solar system moves through space and a trailing edge flowing in the opposite direction. Several indicators will signal the passage of the



spacecraft out of the heliosphere. Instruments onboard the spacecraft are sensing the Sun's magnetic field and the solar wind. Scientists expect that when the spacecraft leave the Sun's magnetic field, the exit will be signalled by a change in the speed, direction, and character of the particles the spacecraft sense. In addition, the spacecraft are picking up radio pulses believed to come from the heliopause, the farthest reach of the heliosphere. The signals could come from charged particles in interstellar space pushed aside by the heliopause. If this proves true, Voyager 1 could cross into interstellar space as soon as 1991.

When Voyagers 1 and 2 were launched in late summer of 1977, the NASA-approved Voyager mission extended only slightly beyond Voyager 2's encounter with Saturn in August 1981. As both spacecraft were operating well after Voyager 1's successful Saturn mission, NASA and Congress approved the current Voyager Uranus/Interstellar Mission, which extends through March 1986. Voyager 2's Neptune mission, along with the continued operation of Voyager 1 through this period, is included in NASA's budget plan as a new start in fiscal year 1986, and no problems are anticipated in receiving funds to fly the Neptune mission.

Extended observations of Uranus will begin on November 4, 1985 and continue through February 25, 1986. Future issues of the Voyager Bulletin will focus on preparations for the encounter, including the health of the spacecraft, science objectives for the encounter, and capabilities for sending and receiving data over large distances.

**An astronomical unit is the Earth's mean distance from the Sun, 150 million kilometers (93 million miles).*

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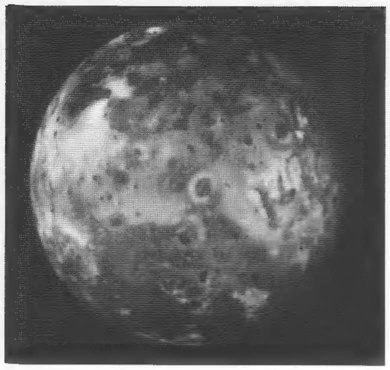
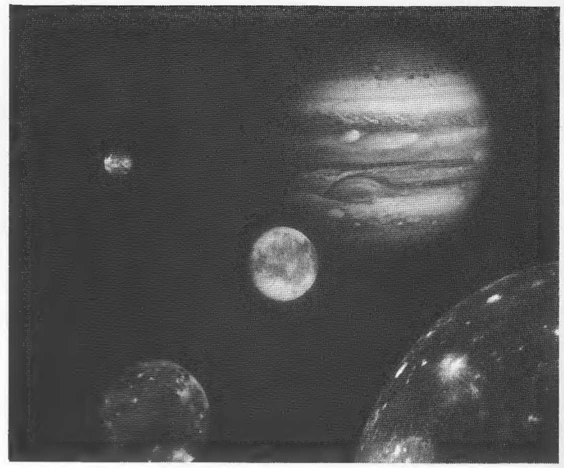


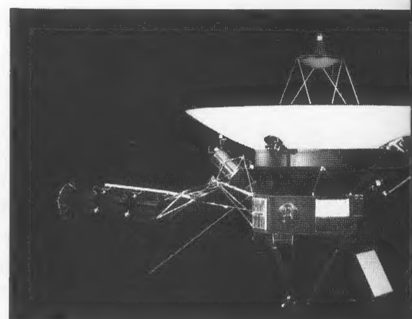
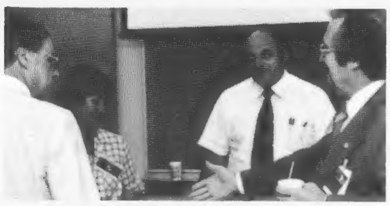

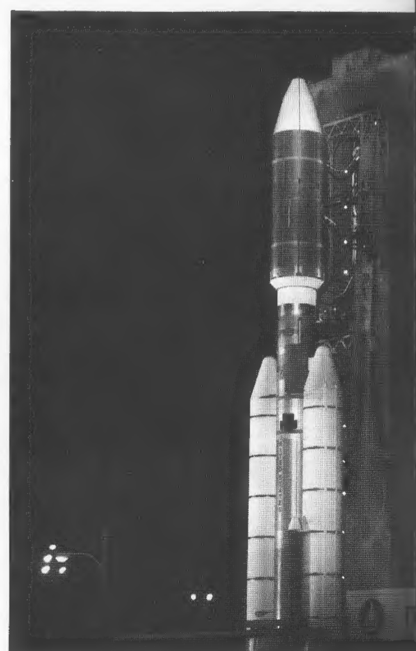
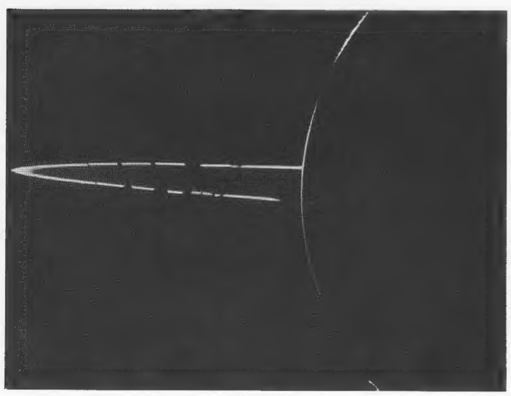

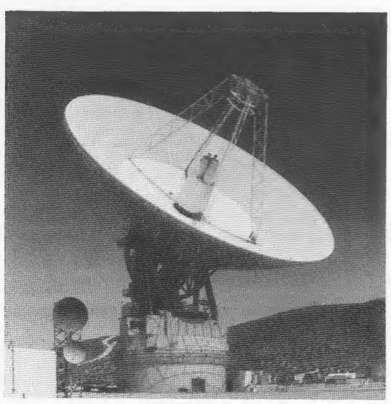

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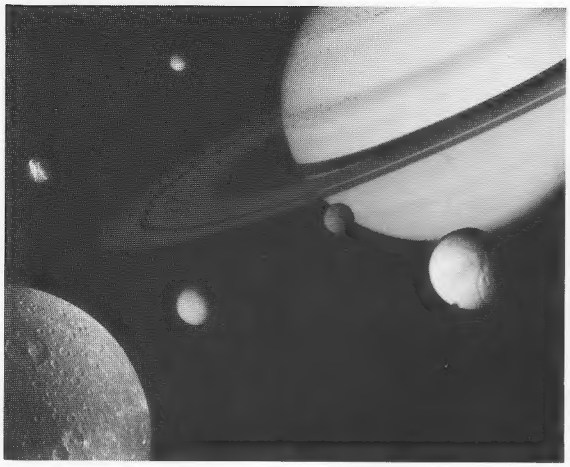
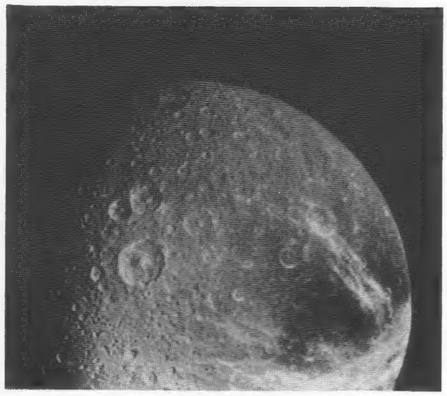
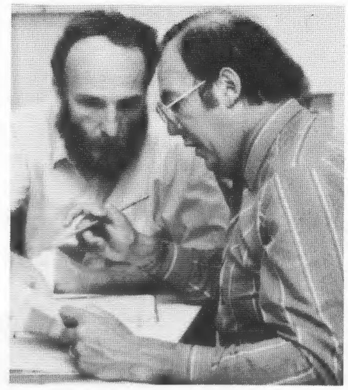




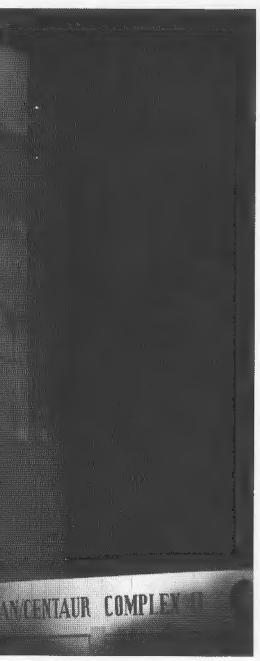
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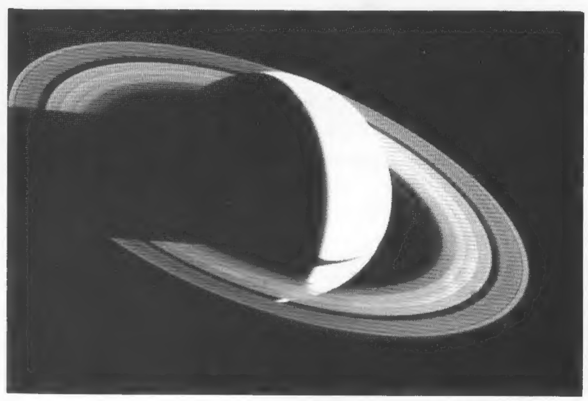

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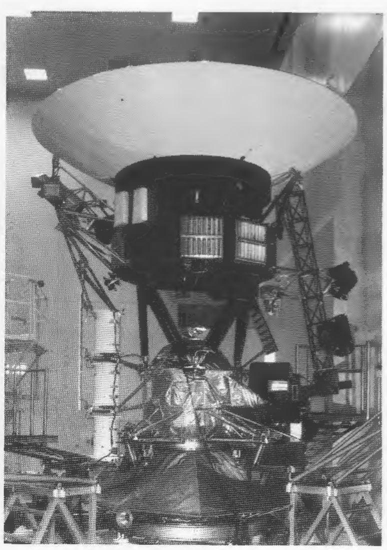
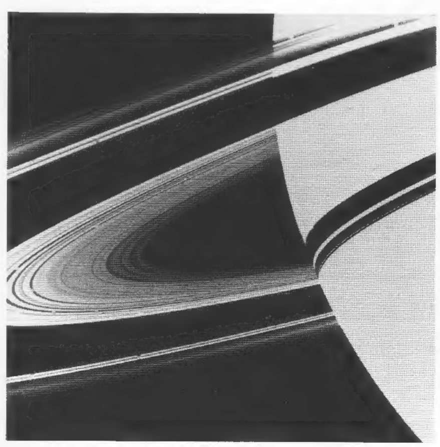



Uranus

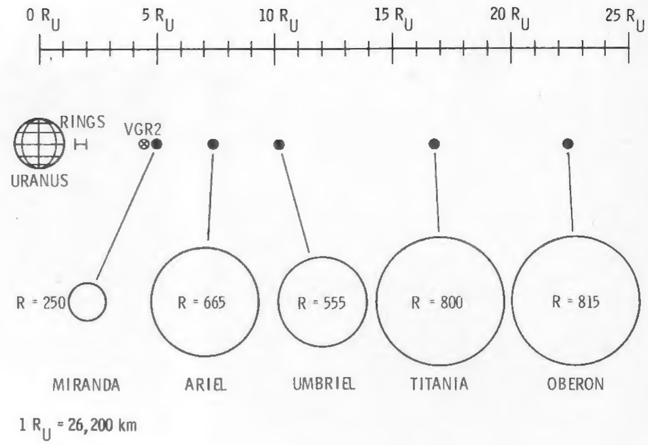
Relatively little is known about Uranus due to its great distance from the Earth. Unknown to the ancients, it was discovered in 1781 by Sir William Herschel, and its very dark ring system was not discovered until 1977. Voyager 2 will truly be a pathfinder as it will be the first spacecraft to observe Uranus from close range.

Uranus is the seventh planet from the Sun, and is almost a twin in size to Neptune, the eighth planet. [Both rank in size behind Jupiter (the largest planet) and Saturn.] It orbits the Sun at about 19 astronomical units* and makes one revolution every 84 years.

Uranus, its rings, and satellite orbits present a bull's-eye target to Voyager 2: the planet is tilted on its rotational axis and the illuminated pole presently points almost directly to the Sun. This unique orientation means that significant events of the Uranus encounter, such as satellite encounters and ring plane crossing, will be compressed into about 5-1/2 hours, as compared to 35 hours for the approaches to Jupiter's Galilean satellites and 13 days for the satellites out to Phoebe's orbit at Saturn.

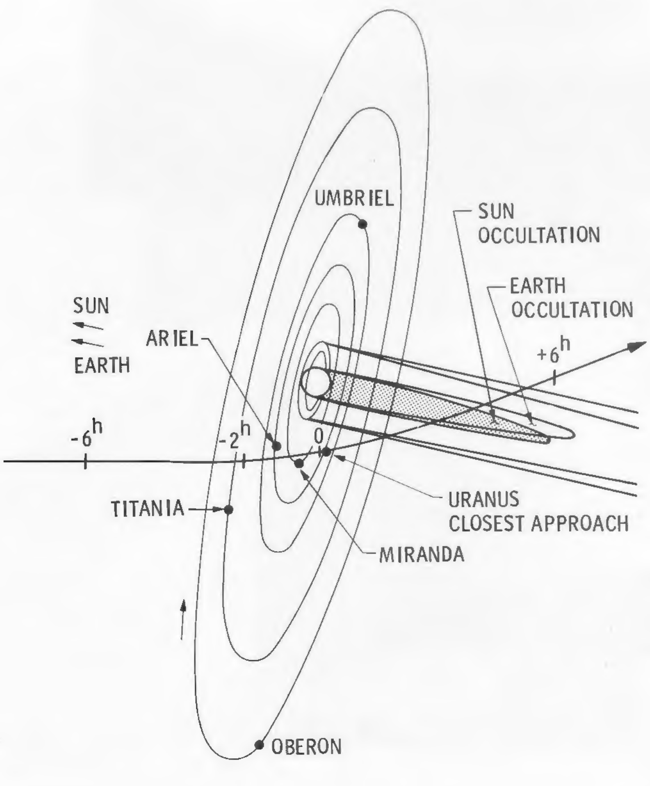
Voyager 2 will try to pin down the radius of Uranus, now thought to be about 26,200 kilometers (16,300 miles), and its rotation rate, which is believed to be about 16 hours. Current theories also propose a composition that is about 24 percent rocky core material, 65 percent icy mantle, and 11 percent hydrogen-and-helium-rich atmosphere by mass. The planet's density is about 1.19 grams per cubic centimeter.

There are five known satellites of Uranus: ranging outward from the planet, they are Miranda, Ariel, Umbriel, Titania, and Oberon. They are slightly smaller than Saturn's large icy satellites Dione, Iapetus, and Rhea, with diameters ranging from 500 to 1630 kilometers (300 to 1000 miles). Although their surfaces are fairly dark, they are probably of water ice. Titania and Oberon appear to be denser than



Umbriel and Ariel, while the density of Miranda is too poorly determined to make comparisons. There is some speculation that whatever catastrophic event caused Uranus to tip on its side may have also deeply affected the satellites, and they may be the highlight of the Uranus encounter.

Since the Uranian rings were discovered by astronomers in 1977, a total of nine sharp-edged, narrow ringlets has been observed; some of them are eccentric (that is, non-circular) and some are inclined to Uranus's equator. Ranging outward from the planet, they are designated 6, 5, 4, alpha, beta, eta, gamma, delta, and epsilon. Their widths range from half a kilometer to nearly a hundred kilometers and they spread from about 41,880 to about 51,190 kilometers from Uranus. The eccentricities may be caused by the pull of small satellites embedded in the rings or orbiting nearby. One of Voyager 2's prime activities will be to scan the rings for such small bodies. Recently, two members of the Voyager Imaging Team, Brad Smith and Rich Terrile, photographed the rings in the infrared using an Earth-based telescope with a charge-coupled device (CCD).



Although it has not been established that Uranus has a magnetosphere, it is reasonable to expect to find one there since the planet is similar to Jupiter and Saturn in many other respects. The International Ultraviolet Explorer (IUE) spacecraft has observed hydrogen emissions at Uranus that have been attributed to aurora, phenomena that are caused at other planets (including Earth) by charged particles spiralling into the planet's atmosphere along magnetic field lines. Voyager 2 will encounter the Uranian magnetosphere nearly pole-on, presenting the opportunity for some interesting magnetospheric studies at high latitudes.

Voyager 2 has been observing Uranus for well over a year now, but only recently have the images taken for optical navigation and photometry purposes begun to exceed the resolution available from the best Earth-based telescopes. They show a fuzzy grey disk a few pixels across; the rings are not visible. The images are used mainly for targeting and determination of reflected light as a function of viewing angle. As Voyager 2 homes in and the images become sharper, scientists will try to identify and track cloud features in efforts to determine the rotation period of Uranus' atmosphere. If Uranus is like Jupiter and Saturn, the planetary radio astronomy (PRA) experiment should be able to measure the interior rotation rate of the planet. A comparison of these two sets of measurements will let scientists deduce atmospheric wind speeds.